E/CONF.39/A/91
10 Oct.1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item: A.2

Economic Commission for Asia
and the Far East

UTILIZATION OF WATER RESOURCES IN MONSOON AREAS OF SOUTHEAST ASIA

By Bureau of Flood Control
and Water Resources Development,
ECAFE, Bangkok

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

NOTES

1. Papers selected for inclusion in General Sessions will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

2. Papers selected for inclusion in Specialized Sessions will be available at the Conference in only one of the above official languages.

3. Summaries of all papers, as submitted by contributors, will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

4. Papers and summaries will not be available for general distribution in advance of the Conference. They will be published in advance in limited quantities only for the use of delegations of participating governments and of other authorized participants. Post-Conference publication and general distribution of the Conference Proceedings will follow United Nations practices as laid down by the United Nations Publications Board.

UTILIZATION OF WATER RESOURCES IN MONSOON AREAS OF SOUTHEAST ASIA

by

Bureau of Flood Control and Water Resources Development
ECAFE, Bangkok

****

I. Pattern of water use in rice culture in South-East Asian countries

1. According to our recent studies on the utilization of water resources in the monsoon areas of south-east Asia, it can be said that, in general, the present pattern of utilization of water resources has been developed to suit the living conditions of the people in this region.

2. In a report presented by Mr. G.P. Jamme (BTAO expert) in 1959 to the Committee for Coordination of Investigations of the Lower Mekong Basin, he observed that, if the Mekong Committee, which is currently undertaking the investigations of the Lower Mekong Basin, wished to change the pattern of floods by constructing dams on the upper part of the Mekong river for power development, irrigation, flood control and so on, it would also be essential to introduce a new pattern of rice culture adapted to the new condition created as a result of the development of the basin. This is because today, in the Mekong delta, some fourteen species of rice are well distributed throughout the delta region adapted to the present natural conditions of flooding, such as the rate or speed of inundation, date, depth and duration of the flood and so on. Also, in the case of these deltaic areas, inundation itself has kept up the fertility of the soil for centuries.

Maximum yields as verified by the Indo-China Rice Office[1/]

	Varieties	Yield (kg/ha)
Floating		1,304
Semi-floating		1,800
Single-transplanting	Early season	1,889
	Mid-season	2,465
	Season	2,337
	Late season	2,361
Double transplanting	Early season	2,231
	Mid-season	3,065
	Season	3,059
	Late season	2,749
Land from which flood water has receded		1,639
Dry land		1,200

1/ Report No. TAA/AFE/7, prepared for the Committee for Co-ordination of Investigations of the Lower Mekong Basin by Mr. G.P. Jamme.

3. It is also reported by SOGREAH recently in its study on the Battambang tributary project of the Mekong scheme that the varieties of rice now grown in the Battambang region, in southwestern part of Cambodia, are long cycle rices, with a not too variable date at blossoming. The quality of long cycle rice is generally not so good; it is rather breakable, and the yield is so poor that it has been suggested that to improve the quality, it is better to replace this variety with shorter cycle rice and to use fertilizer. In attaining this objective, it is also pointed out, the farming operations could easily be spread over three months. This will also make it possible to spread out the maturation and harvest period more satisfactorily. Thus from time immemorial, the present day rice culture has been developed, adapted to the natural environment. Therefore, in order to establish more efficient rice culture for the region, it is obviously necessary to build up a new environment suitable for a new culture.

4. Rice is the staple food in southeastern Asian countries. Rice fields occupy the major portion of cultivated land and rice culture has followed a traditional pattern for many centuries. According to recent statistics concerned with rice culture in Thailand, around 60 per cent of the total arable land is cultivated as rice fields and nearly one-half of the rice fields are located in Central Thailand in the Chao Phya River basin where 58 per cent of the total rice is produced. In an analysis of statistical data concerned with rice production, it is reported that the variation in production since 1939 to 1944 ranges to 31.1 per cent of the average and especially in the case of Central Thailand it extends to 38.8 per cent, and when limited to Chao Phya deltaic area, the figure becomes approximately 60 per cent. It is expected that the rate of yield of the variety commonly grown is well correlated to the highest water stage of the Chao Phya River in any year. The average of annual maximum water stage recorded during the past 120 years of Chao Phya River at Ayuthaya was 3.65 m in gauge reading, while the maximum observed was 5.23 m in 1831 and the lowest was 2.30 m in 1919. The yield of rice was rather stable during the years of high water stage of between 3.50 m to 4.20 m, but there appeared clearly a decrease in yield in the years when the high water stage was higher or lower than the above figures. These facts also suggest that the present day rice cultivation has been built up basically to conform to the conditions bestowed by nature.

5. These are the facts we are now facing in the course of economic development in this region. The author would like to point out that the hydrometeorological condition is one of the most important elements which brought about the present day pattern of rice culture in the southeastern Asian countries. We should note that this is making it difficult to introduce new patterns of rice culture to meet the production requirements of to-day.

II. The flow regime of rivers in southeastern Asian countries - Our recent experiences in the field of hydrology in this region

6. Some very interesting and pertinent facts are revealed by recent studies in the field of hydrometeorology in this region. A few examples such as the Mu River in Burma, rivers in the northeastern part of Thailand and in the western part of Cambodia, are discussed in the following paragraphs.

7. Records of the Mu River discharge were maintained at Kabo weir from 1906 to 1941. The records were started again in 1946 and have continued until to-day with the exception of 1949. The Mu River is a tributary of the Irrawaddy River and

is located in Central Burma. Kabo weir was built early in this century to divert water for irrigation. The total catchment area above Kabo is about 12,400 km^2. Unfortunately the discharge records from 1906 to 1941 kept in Burma were lost during the war years. As such records are very useful for correlating river discharge with rainfall records, we are now trying to locate the missing records for use in connexion with the formulation of a plan for the development of the river, but have not yet been successful. According to the existing records of 15 years, the maximum flood recorded was 7,700 m^3/sec which occurred in 1956 and it was mentioned that another large flood which occurred in 1928 was 5,300 m^3/sec. As for the discharge during the dry season, it has dropped to as low as 1.3 m^3/sec. nearly every year and the lowest recorded was 0.8 m^3/sec. The recorded annual flows at Kabo weir for the period 1946 to 1956 were as follows:-

Maximum (1956)	10,686 million m^3
Average	4,257 million m^3
Minimum (1951)	2,160 million m^3

8. Rainfall records in the Mu River basin were maintained from 1901 to 1940 at eleven stations. All recordings, however, were stopped from 1941 to 1945 because of the Second World War. Maintenance of records was resumed in 1946, but only at the stations below the Kabo weir, and has continued to date with the exceptions of 1947 and 1948 for which there are no adequate records. Rainfall readings at the stations above Kabo weir stopped in 1941 and have never been resumed. According to the records maintained at Kabo during the past forty years, the maximum rainfall was in 1928 which was 1880 mm and the minimum of 670 mm occurred in 1920, the average is 980 mm.

9. This is a rough picture of the hydrological status of the Mu River basin. It can be noticed at a glance that these figures vary widely; the ratio of the maximum and the minimum discharge rises to nearly 9,000, and that of the annual flow is around 4.9 while that of the annual amount of rainfall is around 2.9.

10. We have some data on the hydrological status of northeast Thailand prepared by a Japanese team investigating the potential Nam Gam project for the Mekong Committee. In this region, there is a lake called Nong Han and the records of the lake level have been maintained by the Department of Fisheries since 1949. The total catchment area above Lake Nong Han is estimated around 1,460 km^2. The annual inflow to the lake, which means the out flow from this basin, was calculated by using the recorded lake levels and gives the maximum annual inflow to the lake of 945 million m^3 in 1953 and the minimum of 339 million m^3. Converted to terms of depth per unit of catchment area, the maximum inflow in 1955 was 653 mm per km^2 and the minimum 230 mm per km^2. As for rainfall, one station, which was established in Sakon Nakorn located near the lake, has a record of 13 years which shows the maximum annual precipitation of 1,704.1 mm in 1953 and the minimum of 991.9 mm in 1955. Since that time three additional rain gauges were set up in this basin. Using these records, the annual rainfall for the entire basin was

calculated in the following tabulation. The computed run-off coefficient of the entire basin shows rather wide differences, covering a range from roughly 40 to 20 per cent. Some difficulties were also experienced in correlating these values of run-off coefficient and annual rainfall.

Annual Inflow and Outflow Coefficient of Lake Nong Han[2/]

Year	Annual inflow to Lake Nong Han (Aug. to Dec.) mm	Annual precipitation estimate for entire basin mm	Estimated outflow coefficient for entire basin %
1949	559.1	1,701.0	32.86
1950	572.6	1,533.4	37.34
1951	502.2	1,364.9	36.79
1952	526.7	1,347.9	39.08
1953	653.6	1,638.9	39.88
1954	373.6	1,408.7	26.52
1955	230.5	977.3	23.59
1956	512.7	1,533.3	33.44
1957	275.3	1,340.6	20.54
1958	319.3	1,356.1	23.55
1959	270.7	1,168.7	23.16
1960	408.4	1,689.3	24.18
1961	569.1	1,775.7	32.04

11. Measured stream flow in the Nam Gam basin is only available for 1961 at the proposed Nam Pung dam site. Measurements were taken by the Government of Thailand from which the following tabulation was compiled. From these figures, it can be said that the run-off status of the river varies with the date of rainfall. For the early monsoon season, even under rather heavy rainfall, less than 10 per cent of precipitation runs into river. In the latter part of the monsoon season, the run-off coefficient rises up to nearly 60 per cent. This analysis shows that even the total amount of precipitation may be nearly the same, there can be a wide variation in rate of run-off or stream flow from the drainage area depending on the changing of pattern of rainfall. This makes it difficult to estimate the flow status from rainfall records.

2/ Interim Report on Preliminary Studies of Nam Gam Project prepared by Japanese Government Investigation Team on the Nam Gam Project, August 1962.

Date	Rainfall (mm)	Run-off coefficient (%)		
		Base flow	Surface flow	
29 Sept. - 3 Oct.	85.6	21.3	29.2	50.5
24 - 27 Sept.	117.6	15.3	43.3	58.6
31 Aug. - 4 Sept.	100.5	8.1	25.5	33.6
20 - 23 Aug.	91.4	3.8	37.7	41.5
29 June - 2 July	63.5	3.7	19.3	23.0
24 June - 27 June	144.5	0.1	7.5	7.6

12. The feasibility report on the Nam Pong project in Thailand prepared by Rogers International Corporation, shows that the seasonal variation of flows in the Nam Pong is characteristic of all streams in Northeastern Thailand. In the late dry season, at the Pong Neeb damsite, where the catchment area is 11,980 km^2, the flow is scarcely measurable, while during the rainy season peak flows often reach 1,000 m^3/sec for short period and a figure of 2,000 m^3/sec is estimated as peak discharge of a typical large flood. The average annual discharge for the six complete years, 1955 through 1960, was about 1,780 million m^3 varying from 1,309 million m^3 in 1955 to 2,182 million m^3 in 1959.

13. To estimate storm design hydrographs for use in the selection of a maximum flood hydrograph for spillway design and reservoir operation studies, both unit hydrograph techniques and multiple regression analysis were employed. However the results were not entirely satisfactory. It is reported that difficulties were encountered in estimating the true rainfall in such a large catchment basin when storm rainfalls vary considerably throughout the basin; the rainfall distribution is too irregular for satisfactory use in the unit hydrograph concept and the regression analyses are probably effected by lack of consistent concurrent data, insufficient number of precipitation stations representing the whole catchment and the inability to make consistent estimates of the influence of its various factors affecting the run-off. A flood hydrograph was finally adopted by direct comparison of storms causing the recorded peaks which were recorded in the period of daily records, namely 1921 onwards.

14. The province of Battambang is in the northwest of Cambodia. The first phase report on the development of Stung Sangker which runs through the province was recently prepared by SOGREAH. The following statement is made regarding the flow regime of the Stung Sangker. Ten rainfall stations have been in operation since 1960. They are, however, all located outside the catchment area with the exception of the Battambang station which has been in operation for a number of years, from 1928 to 1940 and 1950 up to date. Unfortunately, the values and regime of rainfall observed at these stations were found to have no relationship with the flows measured at Treng and Banan. It was reported it was not possible to connect the known precipitations (on the monthly scale as on the annual scale) with corresponding run-off volumes.

This is believed to be due to the fact that the upstream precipitation must be of a regime and a scale quite different from that observed from the existing climatological network. The catchment area at Treng is 2,142 km^2 and tentatively the maximum probable flood discharge is estimated as 2,500 m^3/sec by analysing the high water stage records observed in the past using the rating curve prepared for this purpose.

15. The foregoing discussion is limited to only a few examples of the flow regime of rivers in this region. In every case, however, the figures on hydrological status differ so widely that it is quite difficult to estimate the real regime, such as maximum probable flood discharge, variation in annual run-off and flow discharge and so on. An assumption is that these variations are generally inherent in the nature of the monsoon itself. Of course, topographical conditions will have some influence on the pattern of rainfall; also the flow regime of a river can vary widely due to the location and area of its catchment basin. As a result, these hydrological data appear rather unstable which makes it difficult to promote more efficient use of water resources in this region.

III. To-day's demand on water resources in southeastern Asian countries and measures to meet this requirement

16. The explosive increase of population after the last war, especially in the countries of this region, is unprecedented in history and has now assumed a form which calls for immediate solution by many governments. At present, the annual rate of growth of the population in this region is estimated at around 3 per cent. It is reported, even in Thailand where today about 20 per cent of the total rice production is exported, the country will face a deficiency in food supply within ten years, if the present rate of growth of population of nearly 3 per cent per annum continues without a corresponding increase in rice production. According to our experiences, as far as agriculture is concerned, it is quite difficult to keep up with such a high rate of growth over a period of ten years even though the country is favoured by natural and socio-economic environment. Therefore, in countries where agriculture is predominant in the economy, continuous efforts should, of course, be made to increase agricultural productivity as well as its total product. Rapid promotion of industrialization is also assuming great importance and urgency.

17. The efforts to raise the living standard of the people of countries call for many projects related to the better use of water resources in various sectors of the economy. Many hydraulic structures, such as dams for reservoirs, intake structures for irrigation, power etc., canal systems for irrigation and navigation and dykes for flood prevention and so on, have been constructed or are under construction or planning in this region. As it is mentioned earlier, these projects have brought with them new problems, requiring urgent solution.

18. In recent years some irrigation tanks were built in the region to stabilize and to increase the yield of crops, but it was often reported that the existing pattern of cultivation had made it quite difficult for

the users to absorb the modernized irrigation system for productive use. Sometimes inadequate spillway capacity of dams specially in case of small scale development have caused flood damage due to structural failure. In certain cases, the demand for electricity cannot follow the production and this has resulted in the power stations, recently established, remaining idle. It should be recognized that modernized industry will require a certain scale and pattern of power supply. At the same time, the pattern of power production will also influence the pattern of the industry in a way to enable the industry to survive in a competitive market.

19. By what ways and means we can respond to the urgent demands on water for the benefit of the people in this region? At first, we have to know more about the hydrological status of the region. The flow of rivers in this region seem to be so unstable and appear rather different individually, due to topography and size of catchment areas. Yet it can be said that these factors will give a certain order of stability in the products of water itself, such as power produced and water supply for irrigation and domestic use. This leads us to the need of more accurate knowledge about the monsoon itself in order to plan more suitable ways for use of water in this region. To attain a clearer knowledge on this subject, more micro-studies will be necessary. As mentioned earlier, there has already been developed in the southeast Asian region a certain pattern of rice cultivation which is well adapted to its natural environment. It must be said that the peoples were quite successful in adapting themselves to their situation. To meet the present day requirement, it is necessary to reorganize the age-old pattern of living to suit the new condition. In this connection, in order to achieve immediate results from investment, the planning itself should be based on comprehensive knowledge of the present day pattern of cultivation and of the future structure of industry in the region. Probably an analysis of future demands for agricultural products will give some idea as to the diversificational type of agriculture which will govern the pattern of land use while an analysis of available resources will serve as a guide to the estimation of future structure of industry.

20. A river is like a long living thing. From its headwater to the sea, a river basin forms one dynamic and organic system. For example, if a dyke is constructed along the reach of a river, propagation of flood will be accelerated which may cause a rise in the height of flood wave and scoring of river bed in the upper reach and silting in the lower. The construction of dams in the headwater of a river basin will also change the pattern of flow in its lower reaches and this will cause not only some change in the flow regime of the river but will add new problems to the original pattern of water use in the river basin. Moreover it can be said that these phenomena are strongly influenced by the geographical characteristics of the basin which the rivers run through, which in turn contribute to the development of certain pattern of living by the people, well adapted to the natural environment. In conclusion, it must be emphasized that if nations wish to promote more effective development of their water resources, a more rational approach is needed to solve these requirements which are now becoming a serious element

in the course of economic development. The activities of Resources Council of Science and Technics Agency of Japanese Government in the field of resources development since it was established in 1947, will serve as an example. Ways of approach to solve these problems are given in the report "Resources Problems of Japan" presented to the Council in 1961. It emphasizes the need for analysis of facts to determine the real factors causing obstacles in the course of development of the country's natural resources and the need to search for solutions which will serve as a guide for further development.

812 E - Oct.1962 - 1,600